REMARKS/ARGUMENTS

This request for reconsideration is submitted in response to the Office Action dated February 24, 2004. Claims 15-21 and 29-36 are pending. Claims 29, 34, and 35 stand rejected. Claims 15-21, 30-33 and 36 have been objected to.

Reconsideration and allowance is respectfully requested in view of the remarks made below.

1. Miscellaneous

As noted in Applicant's previous response, the present application cites an incorrect Attorney Docket Number. The correct Attorney Docket No. is 83175. Please have this corrected in the U.S. Patent Office records.

2. Double Patenting Rejections

Claim 29 was rejected in the Office Action under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claim 3 of U.S. Patent No. 6,083,818, in view of either U.S. Patent No. 5,930,669 (hereinafter "Uzoh") or U.S. Patent No. 5,933,753 (hereinafter "Simon"). Claim 29 was also rejected over claim 10 of U.S. Patent No. 6,211,066, in view of either Uzoh or Simon. Claims 29, 34, and 35 were rejected over claims 3 and 7 of U.S. Patent No. 6,566,247, in view of either Uzoh or Simon. Claims 29, 34, and 35 were also provisionally rejected over claims 15 and 20 of co-pending U.S. Patent Application No. 09/137,086, in view of either Uzoh or Simon. Specifically, the Examiner takes the position that it would have been obvious to a person of ordinary skill in the art to modify the process of the various patent claims by depositing a single crystal transition metal onto the barrier film, in view of the teachings of either Uzoh or Simon.

Applicant respectfully submits that the combinations of the various claims with either Uzoh or Simon would not render the instant invention obvious because both Uzoh and Simon teach away from forming a single crystal transition metal on the barrier film, as is required by claims 29, 34 and 35 of the present application.

"To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the

knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Uzoh is directed to a method of fabricating wiring structures, which "contain a continuous, single crystalline conductive material extending though the structure." See Abstract. The single crystalline conductive material in Uzoh is used for providing greater structural integrity for the interface between the via and the wiring level below. Uzoh's device utilizes an open-bottomed via liner structure. Uzoh deposits a liner 30 that can be made of various materials such as Al, Cr, Ti, TiN, W, Ta, TaN, TaN/Ta, Ta/TaN, Ta/TaN/Ta, TaN/Ti, Ta-Ti alloy, Ta-Cr alloy and Ti-Ta-Cr alloys. See col. 4, lines 26-28 and col. 5, lines 52-53.

In Uzoh, after depositing liner 30, a conductive material 32 may be deposited on the surface of liner 30 using conventional techniques. See col. 5, lines 59-61. Uzoh states that a seed layer of conductive layer 32 may be deposited. See col. 5, lines 64-67. The open-bottomed via is then filled with metal layer 34. Uzoh also states that "using Cu in the presence of continuous dissimilar liner material with comparatively higher resistivity at the bottom of the via deters the fabrication of a single crystalline, or continuous interface" and that typically after deposition of a liner or barrier film it is followed by "seed layer deposition over the liner." See col. 2, lines 16-19.

Simon is directed to a method of forming a bottomless liner structure. Simon discusses the formation of a single, crystalline interface in order to provide greater structural integrity for the interface between the via and the wiring level below. Simon has a first layer 10 that acts as a liner layer and can be made from materials that include, titanium, titanium nitride, tungsten, tantalum, TaN, TaN/Ta, Ta/TaN, and Ta/TaN/Ta. See col. 4, lines 37-38. Layer 12 is an insulative layer. Fig. 4 shows a second layer 11, this layer is a seed layer upon which a continuous copper structure can then be formed. Simon also notes that "the presence of a continuous dissimilar liner material with comparatively higher resistivity at the bottom of the via deters the fabrication of a single crystalline, or continuous interface," and that "the deposition of

a seed layer of copper prior to the electroplating of copper creates an environment that is more conducive to electroplating." See col. 2, lines 21-27. Simon notes that a "copper seed layer facilitates the formation of single crystalline copper structure at the via-metal interface because the seed layer is structurally similar to the electroplated material." See col. 2, lines 27-30.

In Applicant's instant invention, and stated in claim 29, the barrier film comprises "a monolayer of metal atoms, said metal atoms being selected from the group consisting of barium, strontium, and cesium atoms, singly or in combinations thereof." The usage of these elements in the formation of the barrier film provides an advantage over the prior art in forming the single crystal transition metal on the barrier film. In an example, using a BaF_2 layer for the barrier film, a single crystal transition metal was formed on the barrier film using copper. Applicant notes that, "the copper layer has strong adhesion to the BaF_2, exemplified in part by the single crystalline nature of the metal layer." See Applicant's specification at page 29, line 22-page 30, line 1. Applicant further notes that with certain diffusion schemes, such as that of Uzoh and Simon, "sometimes a "seeding" layer is required on the top surface of the barrier in order for the copper atoms to adhere to the barrier material." See Applicant's specification at page 30, lines 3-4. The present specification further states, "it is also apparent that no such "seeding" is required in the scheme of this invention." See page 30, lines 5-6.

Neither Uzoh, nor Simon uses a barrier film comprising a monolayer of metal atoms selected from a group consisting of strontium, barium and cesium atoms. Instead, they both use different elements to form their respective barrier films. See above. Both Simon and Uzoh discuss using a single crystalline copper structure in the formation of their semiconductors. See above. However, both Uzoh and Simon note the difficulty in forming single crystalline copper structures, and that providing a "seed layer" usually remedies any problems encountered. Uzoh and Simon both note that when using copper, typically a seed layer is formed on the barrier layer in order to facilitate the formation of the single crystalline copper structure. See above. In contrast, due to the nature of the material used in Applicant's barrier film no seed layer is required. Applicant can form a single crystalline copper structure on the barrier film without a seed layer due to the strong adhesion copper has with barrier films having a monolayer of metal atoms selected from a group consisting of strontium, barium and cesium atoms.

Applicant therefore submits that one of ordinary skill in the art would not look towards Uzoh and Simon to teach "forming a single crystal transition metal on the barrier film," since both Uzoh and Simon teach different materials for the layer immediately below the transition metal layer, i.e. Uzoh and Simon do not consider forming a transition metal layer on strontium, barium or cesium.

Moreover, when faced with the problem of the present invention, i.e. to form a single crystal transition metal layer with good adhesion on a barrier film without use of a seed layer, the skilled person would not consult Uzoh or Simon since these references each indicate the desirability of providing a seed layer first, and then providing the single crystal transition metal. Applicant submits that one of ordinary skill in the art looking to Uzoh and Simon would have determined that a seed layer is needed for the best results due to the nature of the barrier films used in Uzoh and Simon, thereby placing a seed layer and then placing the single crystal transition metal on the seed layer, not the barrier film. In contrast, Applicant's barrier films do not require a seed layer in order to form the single crystal transition metal due to the strong adhesion of the materials used.

Applicant respectfully requests the removal of the double patenting rejection of claims 29, 34, and 35 based upon the combinations with Uzoh and Simon. Additionally, Applicant submits that claims 15-21, 30-33 and 36 are allowable by virtue of their dependence upon allowable claim 29.

3. Conclusion

Applicant has made an earnest effort to place this application in condition for allowance.

Respectfully submitted,

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